MOP-6822

TITLE: DETERMINING THE GEOGRAPHICAL LOCATIONS OF THE ORS MEASUREMENT LOCATIONS

SCOPE: Outlines procedures used to determine the precise geographical locations of Optical Remote Sensing (ORS) measurement points and other features of the site.

PURPOSE: Documentation of instrumentation/mirrors location, and site description and map references.

1.0 PROCEDURE

1.1 General

The ORS group uses two instruments to determine the geographical locations of measurement points: a theodolite and a global positioning system (GPS). The theodolite is used to reference the location of the mirrors to the ORS instruments. The theodolite is also used to reference the location of sources or other points of interest to the ORS instruments. The GPS is used to precisely pinpoint the location of instrumentation and any other features about the site. The GPS coordinates can be used to place the instrumentation and other features of interest onto digitized maps. These maps are always based on coordinate references and these references should be determined before collecting GPS data. Section 1.2 describes the operation and data collection procedures for the theodolite. Section 1.3 describes the operation, data collection, and data processing procedures for the Magellan-Platinum hand held GPS instrument.

1.2 Procedures for Operating the Theodolite

The theodolite is a telescopic instrument, mounted to swivel both horizontally and vertically, that is used to measure vertical and horizontal angles, and distances. The internal memory stores up to 2,400 points that can be downloaded to any computer using a data transfer program.

The theodolite tripod should be set up within one meter of the ORS instrument. If the theodolite is being used to measure the coordinates of mirrors, the theodolite can be aimed to the actual mirror. If the theodolite is being used to measure the coordinates of another feature at the site, a small mirror mounted on a surveying staff must be placed at the location of the feature.

Step-by-step procedures for operating the theodolite are as follows.

1. Attach the theodolite to the tripod, and the small mirror to the surveying staff.
2. Balance the theodolite (using the circular bubble level located on the base of the instrument as a reference) by adjusting the tripod extensions.

3. Rotate the three black knobs on the theodolite base to align the horizontal bubble level located on the front of the instrument.
4. Turn the instrument on and rotate the lens one revolution to set the vertical reference point. The instrument will beep when this process is complete.
5. Using a handheld compass, find any fixed object located at a heading of approximately magnetic north from the location of the theodolite. Coarsely align the theodolite on this object by using the triangular site located on the top of the instrument. Precisely align the theodolite on this instrument using the crossbars seen through the lens. Set the horizontal reference point by hitting "Ø set" when the instrument is properly aligned on the fixed object. Press the F3 (yes) button to confirm the location of the horizontal reference point.
6. Set the measurement mode by pressing the triangle-shaped button located to the right of the display screen. Next, page down (using the F4 button) to page 2 (P2), and change the measurement mode to meters by pressing the F3 button. Once the measurement mode has been changed, return to page 1 (p1) of the instrument display.
7. To measure the coordinates of a target, align the theodolite on the object using the triangular site and crossbars. Wait for the instrument to beep, then record the horizontal and vertical coordinates and the distance. Press the F1 button to get fixed readings before moving the theodolite to another point.
8. If the theodolite becomes unbalanced during the measurements, it must be rebalanced (using the procedures described above) before proceeding with measurements.

A detailed diagram of the survey area should be recorded in the field notebook by the Field Team Leader. The general location and coordinates of each feature, relative to the ORS instrument, should be recorded in the diagram. For HRPM configurations, it is not necessary to include the vertical angle of measured mirrors.

1.3 Procedures for Operating the GPS

GPS instruments obtain positioning information from satellites orbiting the earth. The longer the GPS is held over a position, the more accurate the data point. For data collected in this procedure, remain over a site for more than 30 seconds, as indicated on the display of the GPS. The GPS setup is important because the setup formats the data stored within the GPS. To date, the following setup configuration has provided the correct data format. The setup configuration needs to be evaluated for each application with consideration to the data format, coordinate system, and map datum.

Step-by-step procedures for operating the GPS are as follows.

1. Turn on the GPS. Starting at "Menu," select "set up," select "Initialize," select "USA," select the state where data will be collected, verify the correct time and date, enter data. Staring at "Menu," select "Coordinate System," select "Primary," select "Lat/Lon," select "Deg/Min.mmm," enter data. Starting again at "Menu," select "Map Datum," select "Primary," and select "NAD 83." Starting again at "Menu," select "Elev Mode," select "3D." Wait for the GPS to acquire at least five satellites, then collect data over each point

for at least 30 seconds as indicated in the display. Using the form included on page 5 of this procedure, record the information necessary for each point. Data/Waypoints are recorded within the GPS unit. Once over the point, not moving, and the GPS display indicates a 30 second average, select and hold down the "GoTo" pad on the GPS for 2 seconds. Make note of the data and record the name/waypoint number of the data point on the data form within this section. Be specific in the location description and draw a map of the site with waypoint numbers included on the map. Select "Enter" on the GPS to save the data point within the GPS. After data collection, these stored data are downloaded using "GPS Utility software."

2. Load GPS Utility, Version 4.10.3, and connect the Magellan GPS. Use the "download all data" in the GPS menu to transfer the data from the held GPS to the computer. Save the data in the "txt" format and label the file with the month and year ("Sept03") the data was collected. This data file should be in the format of degrees and decimal minutes. The file name cannot exceed six characters.

3. Using Excel, open up the GPS file. Start importing at row 14, use fixed width columns, and define all variables in the txt file, including symbols, numbers, and spaces. The purpose of this activity is to process the data into a format that is acceptable for processing. Under the fixed width options, select columns before and after 1) WPT###, 2) Degree Number, 3) Minutes, including decimal minutes, 4) Degree Number, 5) Minutes, including decimal minutes, and 6) Elevation. Leave no spaces unless necessary. A space may be necessary when the elevation changes; for example, from 95 meters to 125 meters. This seems to work well for elevation, but is not always the case for the other parameters. Finish opening the file and keep only the WPT### column and columns with numbers. Save file (keeping the month_year format) in tab deliminated "txt" format and "xls" format.

4. Using Corpscon for Windows, version 5.11.08, "select input format." Choose "Geographic Coordinates NAD 83" and Vertical Datum "NGVD 29" in "meters" units. Select "output format" and choose "State Pane Coordinates NAD 27," Horizontal Configuration Zone "Kentucky North-1601," Units "US Survey Feet" and Vertical Datum "NGVD 29" and Units "US Survey Feet." Under "Convert" select "User Defined Input File," and for field 1 choose "Point Name," for field 2 choose "Longitude," for field 3 choose "Latitude," for field 4 choose "Elevation," for delimitor "Spaces," and for degree format "Degree-Decimal Minutes." Choose "OK" and point the software to the tab delimited txt file saved earlier, then choose "OK." The next window that opens is "User Defined Output File Field Specifications." For field 1 choose "Point Name," for field 2 choose "Northing/ Y Coordinates," for field 3 choose "Easting/X Coordinate," for field 4 choose "Elevation," and for other choose "Spaces" then click "OK." In the "User Defined Output File window, select the input file and add a "C" at the beginning of the file name (Sept03.txt is changed to Csept0.txt). The file names cannot have more than six characters. Click "OK" and review the Corpscon window for errors. If everything looks good, click "Done." The Horizontal Configuration Zone is different for each state. The Louisville, KY site used "Kentucky North-1601"and the Aiken South Carolina site used "South Carolina-South."

5. Using Excel, open the newly created Corpscon file. Combine the original Excel data file and newly created State Plane Coordinates file. Label the columns as follows:

ID Waypoint	Latitude	Longitude	Northing	Easting	Alt (m)	Alt (ft)	Date	Location	Comment

Fill in the fields of "Date," "Location," and Comment." Use the GPS Data Collection Form on the next page for data collection activities.

6. ***Example GPS Data Quality Discussion***: State plane coordinates(x and y in ft) are determined from calculations using geographical coordinates(Lat and Long). The input format geographical coordinates were NAD 83 and the output state plane coordinates were NAD 27, referenced to Kentucky North – 1601 and in units of feet. The geographical coordinates were determined using a USGS freeware software called Corpscon.

When using data in the State Plane Coordinate format, there are two comparisons important to understanding the accuracy of the data. The first is the direct indication of state plane data and geographical coordinates provided at the Waste Management site by the Birch, Trautwein & Mims, Inc. (BT) surveyor, Martin Brush. The BT geographical coordinates were converted to state plane coordinates using USGS freeware software (Corpscon). The calculated values were then compared to the direct indication of state plane coordinates provided by BT. These differences were 4.9 and 1.1 ft. These differences also indicate the accuracy associated with the conversion of geographical coordinates to state plane coordinates.

There were six points of reference available for evaluation of the handheld GPS accuracy. The standard of comparison will be the geographical coordinates provided by BT converted to state plane coordinates, NAD 27 referenced to Kentucky North - 1601. The handheld GPS data, geographical coordinates referenced to NAD 83, were collected for nineteen points over these six points of reference. After converting both handheld GPS geographical coordinates and the BT geographical coordinates to state plane coordinates using Corpscon, a comparison was made.

The results indicated that, in general, the handheld GPS is an average difference of 12.8 feet when compared to the BT data. Differences were as large as 45 ft and as small as .01 ft. The differences also indicate that those differences are dependent upon the amount of time used to collect data at each site. This is demonstrated by WPT's 94, 95 and 96 which are actually the same point. The difference changed from 41 ft to 6 ft differences by staying over a point for a minimum of 30 seconds. It is also important to begin the averaging procedure three different times while remaining over the site of comparison.

GPS Data Collection Form

Date: **Site Location:**

ID Way Point	Latitude	Longitude	Point Location/Comment

Field Diagram

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